Caltrans All Roads Linear Referencing System Fact Sheet

Overview

In 2012, the Federal Highway Administration unveiled a new requirement for State Departments of Transportation to develop and submit a linear referencing system (LRS) network for all public roads in their respective states, known as the All Roads Network of Linear Referenced Data (ARNOLD). This ARNOLD requirement is an integral part of each state's federally mandated Highway Performance Monitoring System (HPMS) annual submittal. To meet the ARNOLD requirement, the Division of Research, Innovation and System Information (DRISI) has developed a representation of all roads in California using a combination of the Census Bureau's Topologically Integrated Geographic Encoding and Reference (TIGER) files and line work representing the State Highway System that had been developed previously.

The Caltrans All Roads LRS dataset provides the base geometry for federally required Highway Performance Monitoring System (HPMS) business data, functionally classified roads for the California Roads System (CRS) (a requirement for federal funding of local agency projects), and the State Highway Network (SHN), which supports a wide range of internal Caltrans business needs.

The Caltrans All Roads LRS has a number of limitations, and there are ongoing efforts to improve data quality and accuracy. Some known issues of the dataset are:

-   Inclusion of an excessive number of minor roads, resulting in many "unnamed" routes
-   Overlapping geometry
-   Missing geometry (gaps)
-   Insufficient accuracy of geometry
-   Incorrect street names, resulting in incorrect route identifiers (LRS_KEY)
-   Incomplete representation of dual carriageways
-   Incomplete representation of roundabouts

Development

The geometry of the All Roads LRS was sourced from the TIGER-based dataset used for CRS mapping and maintained using Esri ArcGIS Desktop. The geometry and attributes were transferred to, and are currently maintained in Hexagon GeoMedia Pro desktop, using Oracle as the data warehouse. Subsequently, accuracy of geometry has been improved and new streets added based on National Agriculture Imagery Program (NAIP) imagery (originally using 2012 vintage and updated to 2014).

The linear referencing system was created by assigning a unique "route identifier" (called LRS_KEY) and a sequence of "measures" to the All Roads geometry. Begin and end measures are based on the geometric length each route segment in thousandths (0.001) of miles as calculated by Oracle (e.g. BEGIN_MEASURE = 25.204, END_MEASURE = 26.544). In general, for non-state highway routes, the LRS_KEY consists of a concatenation of County, Jurisdiction, Street name, Street name suffix, and Carriageway fields (e.g. SAC_SAC_29TH ST_P). LRS_KEY for state highways is based on the Route number and Carriageway appended to "SHS" (e.g. SHS_099_P).

Linear Referencing Methods (LRMs)

The All Roads LRS supports two linear referencing methods: the All Roads LRM and the State Highway LRM. The All Roads LRM is one and the same as the All Roads LRS, where the unique route identifier is LRS_KEY and the begin and end measures are those of the LRS.

The State Highway LRM is more complex. Caltrans identifies locations on the State Highway System using a combination of county, route, possibly a route suffix, a postmile (with a precision of three decimal places, or to the thousandth of a mile), possibly a postmile prefix, and possibly a postmile suffix. Postmiles along a route reset to 0.000 at county lines, and due to realignments and other modifications, postmiles on a route and within a county may overlap or have gaps; in these cases postmile prefixes are applied to differentiate between postmiles with the same numeric value. Some examples of SHN county/route/postmiles are:

County	Route	Route Suffix	Postmile Prefix	Postmile	Postmile Suffix
FRE	99			23.304	
MEN	101	U		99.431	
SD	5		R	30.436	L

In GeoMedia/Oracle, the State Highway LRM is stored as an "event" table (TSN_ROUTE_SEGS) that references the All Roads LRS. The source of this table is the Transportation System Network (TSN) database, which is the Department's system of record for the state highway system. Each record in this table includes the county, route, and begin and end odometer from TSN, and the corresponding All Roads LRS_KEY and begin and end measures.

Next Steps - All Roads LRS High Precision Project

Caltrans is in the process of updating the All Roads LRS dataset utilizing the latest available NAIP imagery as a reference to improve accuracy of the geometry. Work will be completed on a county-by-county basis for all 58 California counties. In this high precision project, all geometry will be reviewed at a maximum scale of 1:2500, and corrected at a scale range of 1:1200-2500. For comparison, ARNOLD requires a minimum scale of 1:24,000. With Caltrans' more precise scale for scanning and editing, the resulting geometry and attribution will be much more accurate. Edits will include:

1. Remove invalid and add missing dual carriageways
2. Check secondary LRS_KEY compliance with associated primary LRS_KEY
3. Assign names to unnamed streets and update associated records
4. Identify possible invalid geometry for Caltrans review
5. Identify and fix overlapping geometry
6. Add new geometry based on latest NAIP imagery
7. Use local agency GIS roads data as a reference
8. Add and update valid roundabouts
9. Ensure ramps connect to state highway network geometry
10. Resolve various errors with measures (e.g. overlaps and gaps) and calculated geometric lengths
11. Address errors identified by internal customers

Anticipated Timeline

There is currently a pilot project to fully implement two counties using the Esri Roads and Highways (R&H) platform. This pilot project is to ensure that all identified Caltrans LRS requirements are met before a statewide conversion is attempted. The project will include the full migration of two counties (with LRS requirements that are representative of all counties) from Hexagon/GeoMedia to R&H.

The pilot project is scheduled to be completed in April 2019. Upon successful completion, a statewide migration project will begin to transition from the current platform to R&H. It is anticipated that the statewide migration project will take 12 months (July 2019-June 2020).

During the statewide migration project, the All Roads LRS High Precision project will need to be temporarily put on paused until the statewide migration project is completed. The All Roads LRS High Precision project (statewide) is anticipated to be completed in June 2022.

The estimated timeline for when districts are anticipated to be completed in the All Roads LRS High Precision project are summarized below along with the anticipated R&H Statewide Migration Project:

1. District 4   – November 2018
   Contra Costa   Jan
   Alameda   Feb
   Santa Clara   May
   San Mateo   June
   San Francisco   July
   Marin   Aug
   Sonoma   Sept
   Napa   Oct
   Solano   Nov
2. District 7   – January 2019
3. District 12   – January 2019
4. District 11   – February 2019
5. District 5   – April 2019
6. District 8   – May 2019

R&H Statewide Migration Project (July 2019 – June 2020) **

7. District 6 **   – April 2021
8. District 9 **   – April 2021
9. District 10 **   – August 2021
10. District 3 **   – January 2022
11. District 1 **   – March 2022
12. District 2 **   – June 2022

** Pending future funding